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Summary of the Meeting

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Plasmas in the Laboratory and in the Universe
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This was a meeting between two large groups of researchers: astrophysicists and space physicists, on the one hand, and laboratory plasma physicists, on the other. The meeting has clearly demonstrated a growing mutual interest of these two groups: presenters of one group tried to make their talks understandable to another group, discussions were very lively, and a number of points for further joint effort have been identified. This was a timely meeting in view of the explosion of observational data from new space and ground based instruments. New phenomena have been observed and/or understood more clearly, including gamma ray burst sources, the Sunyaev-Zeldovich effect, the anisotropy of the cosmic microwave background, high magnetic field pulsars or magnetars, solar acoustic spectroscopy, ultra luminous star burst galaxies, and many others.

Specific talks and posters covered essentially all areas of plasma physics related to astrophysics and space physics, from dusty plasmas, through reconnection physics, to high-energy-density phenomena. Some talks were related to the development of the conceptual framework of the plasma physics, like modern models of the hydrodynamic turbulence, magnetic dynamos, Hall magnetohydrodynamics, and hydrodynamical and magnetohydrodynamic instabilities in rotating systems.

Talks presented by the astrophysicists/space physicists were concerned with a broad range of phenomena: dynamics of the Solar atmosphere, Solar wind, accretion discs, stellar and galactic jets, hot intracluster plasmas, etc. The quality of observational data improved dramatically during the last decade, to great extent because of a large number of missions and new instruments made available during this period. Just one example: in the early years, when the intracluster plasma was first appreciated as an important object (in particular, in conjunction with the Sunyaev-Zeldovich effect), it was usually assumed that this plasma forms a smooth quasi-symmetrical cloud, with an almost uniform temperature. Nowadays (as the talks at this Symposium have clearly demonstrated) we understand that the clouds have no particular symmetry, but rather comprise a number of filaments, blobs and clumps, that they are traversed by shocks, that some parts of them are involved in convection, that the magnetic fields may have a strong impact on their behavior, that phenomena of the type of Solar flares occur in this plasma, etc. So, the whole arsenal of concepts of plasma physics has to be applied to understand this fascinating object.

A tremendous amount of high-quality observational information has been collected in the area of solar physics. It is a real challenge now to the theorists to digest this information and come up with detailed theoretical models.

We have seen a growing impact of powerful computational tools on the understanding of various astrophysical phenomena. New simulation codes have been developed by a number of groups for studying hydrodynamic and magnetohydrodynamic flows in axisymmetric systems and in fully three dimensional systems. The three dimensional codes, which now include in some cases strong radiation fields, run on parallel computer systems and have been used to study MHD turbulence in accretion disks, MHD origin of astropysical jets, strong shock waves in the interstellar medium, etc. In a different approach, relativistic particle-in-cell simulations have been applied to understand pulsar electrodynamics.

The astrophysics-related laboratory experiments have also made remarkable progress in recent years. Much better experimental characterization of the reconnection phenomena has been reached in dedicated laboratory experiments. Experiments with high-power lasers and z pinches have allowed the reproduction, in a scaled manner, of essential features of hydrodynamic flows and instabilities relevant to different astrophysical plasmas. These include experimental formation of supersonic magnetized and non magnetized jets, strong shock waves, and differentially rotating magnetized plasmas where MHD instabilities may appear.

Laboratory experiments on non-neutral plasmas have been reported. In addition to their value as a discovery tool, they are of a great educational value. Concepts of instabilities in rotating systems, self-organization, structure formation, and others can be studied “hands on” in the (almost) table-top experiments. Such experiments could be particularly helpful in training astrophysicists.

The importance of the dusty plasmas in astrophysics has been emphasized in several talks and posters. Not only does the dust determine the ionization degree and, thereby, electrical conductivity in molecular clouds, but it may also serve as catalysts of chemical reactions modifying the chemical composition of dust rings in a process of planetary formation.

In conclusion: this was a timely meeting which helped a lot in establishing working contacts between astrophysicists and laboratory plasma physicists. The common attitude of the participants was that such meetings should continue in the years to come.

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